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The "filter constant" and its role in industrial filtration of viscose.

by Dr. W. Fuchs

1.3 The filter constant.

While the time curve reflects the progress of the filtrate with the advance of time, we now direct our attention to the rate of filtration with increasing amounts of filtrate.

For the course with the advance of time we had already obtained

$$S = \frac{a \cdot b}{(1 + b \cdot t)^2} \quad \text{and} \quad S_0 = a \cdot b$$

We now define the concept of the relative rate of filtration as a relation of S to S_0. The validity of the following equation is obvious:

$$\frac{S}{S_0} = \frac{1}{(1 + b \cdot t)^2}$$

Since equation (1) yields

$$1 + b \cdot t = \frac{E}{E - V}$$

we obtain

$$\frac{S}{S_0} = \left(1 - \frac{V}{E}\right)^2 \tag{3}$$

This important equation therefore reflects the progression of the relative rate of filtration with the increased amount of filtrate V, so far as this filtration conforms to equation (1), since it is derived therefrom.

The decrease A in the relative rate of filtration with increase in the amount of filtrate is obtained therefrom by differentiation according to V

$$A = \left(-\frac{d\frac{S}{S_0}}{dV}\right) = \frac{2}{E}\left(1 - \frac{V}{E}\right) \tag{4}$$

Specifically, at point $V = 0$, i.e. at the start of filtration,

$$A = \left(-\frac{d\frac{S}{S_0}}{dV}\right) = \frac{2}{E}$$

We transform the expression $\frac{2}{E}$ into k, and designate k as the filter constant. The filter constant k therefore represents the decrease in the relative rate of filtration after the passage of one cubic centimeter or one gram of filtrate, respectively, at the commencement of filtration, and simultaneously, the twofold reciprocal quantity of viscose which completely obstructs the filter.

Equation (1) is thereby transformed into

$$V = \frac{S_0 \cdot t}{1 + \frac{k}{2} \cdot S_0 \cdot t} \qquad (1b)$$

and equation (2) into

$$\frac{t}{V} = \frac{1}{S_0} + \frac{k}{2} \cdot t \qquad (2b)$$

The latter formula shows us the method of calculation for the filter constant k. $\frac{k}{2}$ namely is the directional tangent of the line that we obtained upon the plotting of the representation of $\left(\frac{t}{V}, t\right)$ as the progression of filtration. Therefore it is valid, if two reliable points on this line are known,

$$\frac{k}{2}\left(t_2 - t_1\right) = \frac{t_2}{V_2} - \frac{t_1}{V_1}$$

or

$$k = 2 \cdot \frac{\frac{t_2}{V_2} - \frac{t_1}{V_1}}{t_2 - t_1} \qquad (5)$$

We recognize by formula (5) that the filter constant is obtained independently of the utilized measure of time, since this is divided out; it is dependent, however, on the unit of volume with which the filtrate is measured, at the same time dependent also on the chosen filter surface; since the doubling of the filter surface causes a doubling of the amount of filtrate V_1 processed at time t_1 as well as the amount of filtrate V_2 processed at time t_2, which according to formula (5) results in a halving of the mathematical filter constant. The filter surface and the unit of volume must therefore be subjected to standardization, for the purpose of conducting measurements of the filter constant.

Summary.

These calculations reveal firstly, the significance attributable to the concept of a filter constant as an exact physical magnitude in the filtration of viscose, secondly, the possibility of saving the situation by emergency measures in the event of major disruptions in filtration, in order to prevent the collapse of production.

This possibility actually does not effect the aims of production proper, which now as before consist of the manufacture of well-filtrable viscose, which does not require the aid of the enumerated methods. On the contrary, the calculations reveal the advantages inherent in well-filtrable viscose.